PLANT ANNUAL COST DATA FOR SYSTEM DESIGN PURPOSES

Purpose: The purpose of this addendum is to update depreciation and maintenance data in Telephone Engineering and Construction Manual Section 218, Issue No. 3, dated July 1968. The attached Table III replaces the information in Tables I and II of TE & CM-218. A nomograph or alignment chart (Figure 1) is also attached to help introduce cost of money and pair growth rates into outside plant decision making. Figure 2 shows how the alignment chart can be used on individual projects when the standard mile costs are known and the cost of money can be approximated.

Decisions: Strike out Tables I and II in TE & CM-218, Issue No. 3, and add to these tables "See Table III in Addendum 1."

Additions:

9. Depreciation and Maintenance

9.1 The depreciation rates provided in TE & CM-218, Issue No. 3, (Table I) failed to give adequate consideration to obsolescence due to the rapid changes in technology in the telecommunications field. Under-depreciation frequently results in the need to request regulatory body approval for amortizing the undepreciated portion of removed plant not recovered through salvage. It also results in reduced cash flow, with a consequent requirement for increased borrowing and increased income tax. Excessive depreciation prematurely decreases the rate base which is equally undesirable.

9.2 The increased maintenance rates (Table III) are due primarily to higher wage rates and increased vehicle and work equipment costs.

10. Compound Interest Theory

10.1 For many years, the 2 percent interest rate and REA's decision to generally construct the telephone plant required for 5 years' growth made present worth annual charge studies unnecessary.

10.2 The variable interest rates, the wide divergence in growth rates between borrowers and between exchanges in the same system, and the impracticality of attempting to reinforce buried cables several times now make annual charge studies worthwhile. System planners should familiarize themselves with the book "Engineering Economy" by the A.T. & T. Engineering Department available from Commercial Relations Department, Western Electric

Company, Gateway 2, Newark, New Jersey 0701- or "Engineering Economics" by Ollie Smidt (GTE Planning Staff) available from Telephony Publishing Corporation, 5- West Jackson Boulevard, Chicago, Illinois 60604 or a more general book on engineering economics.

10.3 Figure 1: Cost of Money and Circuit Growth Nomograph has been included to help in decision making. It can be used in determining whether a larger cable should be installed initially or to compare different size installations of electronic equipment. Because of the difference in annual charges, it should not be used to compare electronic reinforcement with cable reinforcement.

11. Cost of Money and Circuit Growth Examples

11.1 In the following examples, the Future Worth refers to the number of dollars that will be required to do some predetermined construction some time in the future. In annual cost studies, items that are identical should be removed from the analysis. Figure 1--Cost of Money and Circuit Growth Nomograph is another example of removing identical costs from the alternate studies. A basic assumption is made that the Depreciation, Maintenance, Taxes, and other annual charges can be expressed as a percentage of the installed cost of the facilities and the <u>sum</u> of these individual percentages is identical for the two plans. Therefore, all annual charges except the cost of money can be removed from the analysis. This is a reasonable assumption when comparing two cables of the same type or two electronic plans. It is not a valid assumption when comparing a cable reinforcement with an alternative carrier reinforcement.

11.2 In example 1, another identical cost is removed from the two plans. The cost of the initial installation of a 25 pair cable is eliminated from consideration by deducting its costs from both plans. The present worth of the second 25 pairs in the 50 pair cable is the difference between the cost of the 50 pair and the 25 pair cables. The future worth is the cost of installing a second 25 pair cable in the breakeven year.

11.3 Examples are provided to show some of the uses of the Cost of Money and Circuit Growth nomograph. The method shown in Example 1 generally justifies an increased number of pairs for cables 50 pair and smaller than the minimum recommendations found in TE & CM-210, "Telephone System Design Criteria." The example does not take into consideration the costs of converting the feeder portion of the cable to distribution use, which will vary due to factors such as distance from central office, size of reinforcing cable, or the type of electronic reinforcing facility. These factors should be considered in an actual study. Decisions made through the use of the nomograph generally reduce considerably the effort required to complete the full fledged alternate studies described in the books referred to in paragraph 10.2.

11.4 Figure 2 shows the Cost of Money and Circuit Growth Nomograph prepared prior to beginning cable sizing for a particular system. It assumes the cost of money is 8 percent. The cable costs used to determine the breakeven years are based on the average bid costs of REA borrowers for the period of January 1, through June 30, 1974.

11.5 When uniform growth is expected in an exchange, the initial fill of the various size cables can also be shown on the nomograph. Since in most rural systems cables of 200 pair and less generally contain both feeder* and distribution complements, the initial fill referred to should generally apply to the distribution pairs. It is expected that during the life of the cable the feeder pairs will gradually be converted to distribution use by applying pair gain devices to a reduced number of feeder pairs or by transferring the feeder circuits to an all feeder cable.

11.6 Use of Figure 1

11.61 Example 1: If (1) a 4.5 KF length of 25-24 cable costing $2,000 initially (and 15% additional 5 or more years in the future) has 8 distribution pairs and 7 feeder pairs working at cutover, (2) a 50-24 cable costing $3,000 would appear to meet substantially all of the 25-year requirements of the serving area, (3) the compound interest rate is 7 percent, and (4) the circuit growth rate in this length of cable is expected to be 5 percent compounded annually:

a. What is the minimum number of years before reinforcement of the 25 pair cable with another 25 pair cable is economical?

First compute the ratio of the future expenditure for the second 25 pair cable to the incremental cost of the second 25 pair in the 50 pair cable.

$$\frac{(FW)}{(PW)} = \frac{\$2,000 + (.15 \times \$2,000)}{\$3,000 - \$2,000} = \frac{\$2,300}{\$1,000} = 2.3$$

Using Figure 1 and a straight edge, connect this ratio (2.3) to the cost of money (7 percent), and read the breakeven year (approximately 12½ years). Reinforcement of the 25 pair cable with a second 25 pair cable should not take place in less than 12½ years or the 50 pair cable would be more economical.

b. With the economical choice at 12½ years and if the total pair growth is 5 percent, what is the maximum initial fill?

The economical initial fill determined by laying a straight edge between 12½ years and 5 percent growth is approximately 57 percent.

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* TE & CM-Section 628, "Plastic Insulated Cable Layout," defines feeder and distribution.

c. What is the economical choice in this case?

With 8 initial distribution pairs (32 percent fill), and 15 total initial pairs (60 percent) the 25 pair cable appears adequate.

11.62 Example 2: If (1) station carrier can be installed in 5 or 7 channel groups, (2) field installation of groups at a particular location is to be made no more than once in 18 months, (3) annual circuit growth is 10 to 15 percent and (4) one or more channels is desired for maintenance or providing a new service quickly:

a. What is the recommended percentage for working versus wired channels:

From Figure 1, if breakeven year is 1½ and percent growth is 15, recommended fill is 80 percent or more.

b. What is the recommended fill range for one or more 5 channel groups at the same location?

Group 1	- 3 out of 5 = 60%	4 out of 5 = 80%
Groups 1 & 2	- 5 out of 10 = 50%	9 out of 10 = 90%
Groups 1, 2 & 3	- 10 out of 15 = 67%	13 out of 15 = 87%
Groups 1, 2, 3, & 4	- 14 out of 20 = 70%	18 out of 20 = 90%

c. What is the recommended percentage fill range?

50 percent to 90 percent.

d. What is the recommended percentage fill for one or more 7 channel groups at the same location?

Group 1	- 4 out of 7 = 57%	6 out of 7 = 86%
Groups 1 & 2	- 7 out of 14 50%	13 out of 14 = 93%
Groups 1, 2 & 3	- 14 out of 21 66%	19 out of 21 = 91%
Groups 1, 2, 3 & 4	- 20 out of 28 71%	26 out of 28 = 93%

e. What is the recommended percentage fill range?

50 Percent to 93 Percent.

TABLE III - Middle Range of RE. orrowers' Depreciation and Maintenance Rates

	Depreciation as Percentage of Investment	Maintenance in Dollars Per Unit: Dollars	Maintenance in Dollars Per Unit: Units	Maintenance as Percentage of Investment
Buildings & Grounds	2.4 - 3.0%	-	-	1.1 - 2.4%
Central Office	4.0 - 5.0	$ 7.02 - 10.90/	[Equipped C.O. Lines + 3 (Carrier + Radio) Channels]#	3.1 - 4.3
Station Apparatus	5.0 - 6.7	8.51 - 12.56/	Main Station	6.2 - 9.2
Station Connections	6.0 - 8.0	6.30 or 9.01/	Total Stations	
Large PBX	5.0 - 6.1	**		4.0*
Pole Line	4.0 - 5.0	No Unit		.8 - 2.1
Aerial Cable	4.0 - 4.3	39.32 - 80.11/	Sheath Mi.	1.1 - 2.1
und Cable	3.0 - 4.0	43.00 - 200.50/	Sheath Mi.	.4 - 2.0
and Wire	3.5 - 4.0	16.30 - 31.54/	Sheath Mi.	.8 - 1.5
ble	4.0 - 5.0	*		4.2*
	4.6 - 6.2	7.79 - 19.65/	Circuit Mi. Aerial Wire plus Sheath Mi. Distribution Wire	2.5 - 5.0
Conduit	2.0 - 3.2	16.00 - 92.50/	U.G.C. Sheath Mi.	.1 - .7
Office	6.0 - 10.0	No Data		-
	12.6 - 18.1	No Data		-
tal		24.06 - 48.47/	Route Mi.	1.2 - 2.0
Plant	4.2 - 4.8	26.74 - 37.00/	Main Station	2.9 - 3.9

an empirical value for carrier maintenance of three times the maintenance per COE equipped correlates well with information provided by borrowers with carrier maintenance records. cost studies, the recommended rates for electronic equipment is 5% for depreciation and for

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· data to provide a range.

age as guide.

See "Notes Concerning Table III" for additional information.

NOTES CONCERNING TABLE III

The range shown for central office equipment should apply to common control switchboards.

Central office equipment includes radio, carrier, voice frequency repeaters, and other electronics as well as the cost of transmission power.

Test desk work, when reported as a separate maintenance cost, ranged from 4.6 to 9.9 percent of total maintenance for the middle third of those reporting test desk work.

The depreciation ranges are the rates furnished by the middle third of more than 800 borrowers. The maintenance values given are the middle third of the data provided by approximately 600 borrowers.

TABLE III DEPRECIATION AND MAINTENANCE DATA IS PROVIDED FOR GUIDANCE. IT IS INTENDED THAT AFTER DETERMINING THAT A BORROWER'S DEPRECIATION AND MAINTENANCE RATES ARE REALISTIC, (OR AFTER PRUDENT ADJUSTMENT) THE BORROWERS RATES WILL BE USED IN ANNUAL COST STUDIES.

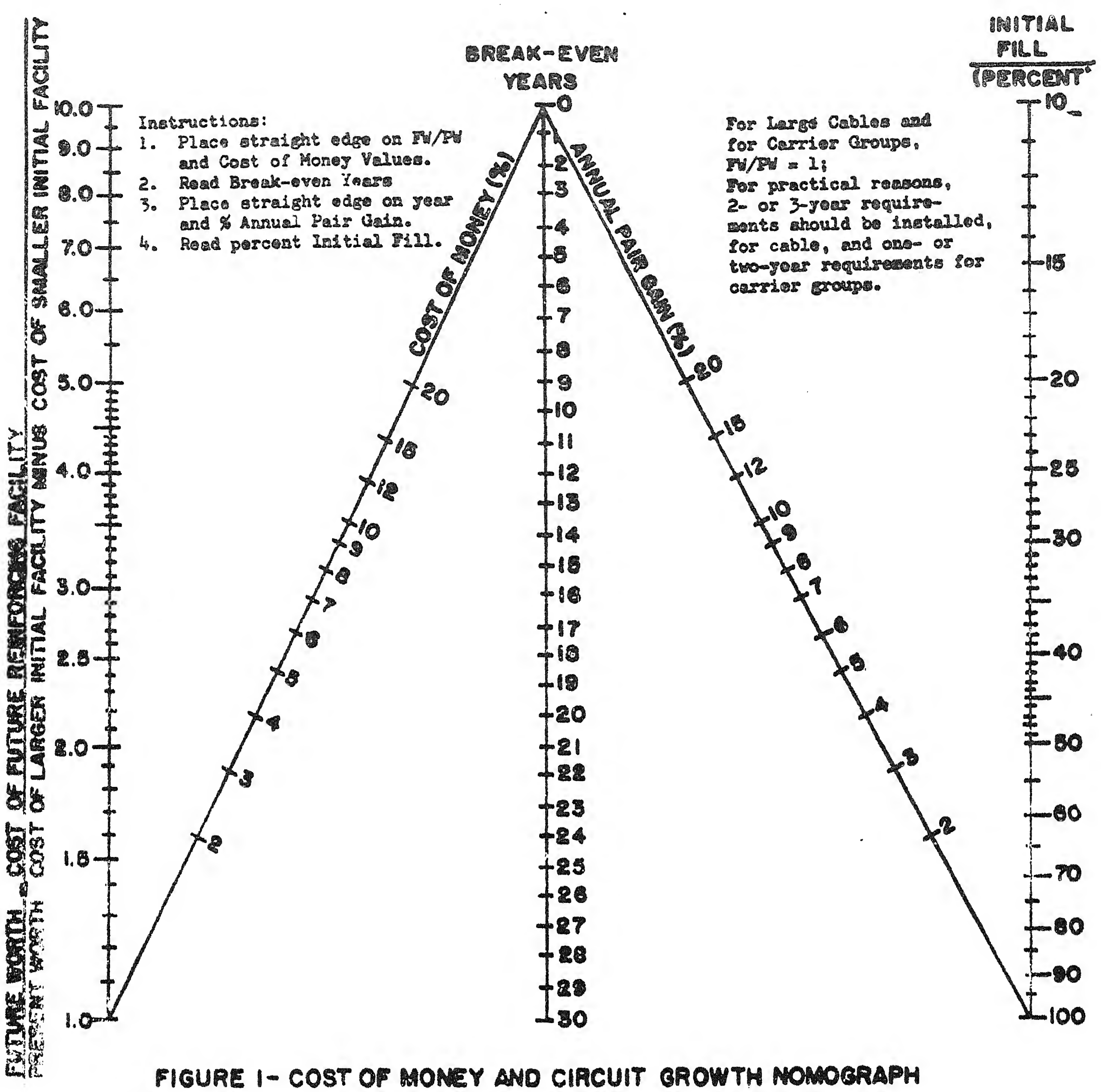


FIGURE 1- COST OF MONEY AND CIRCUIT GROWTH NOMOGRAPH

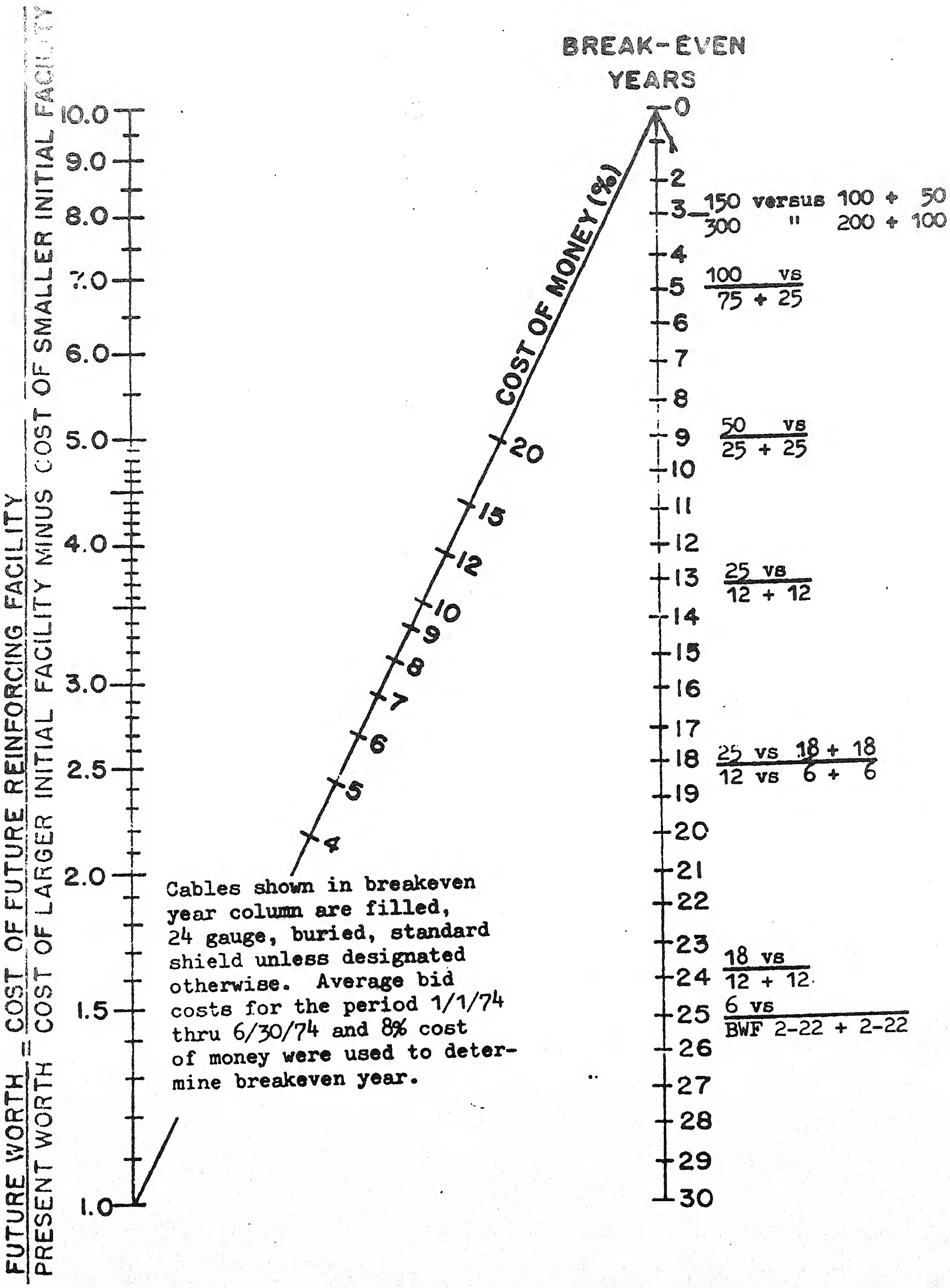


FIGURE 2: USE OF NOMOGRAPH FOR SEPCIFIC PROJECT

PLANT ANNUAL COST DATA FOR SYSTEM DESIGN PURPOSES

CONTENTS

1. GENERAL

1.1 This section provides REA borrowers, consulting engineers, and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It furnishes annual cost data for various items of plant together with information for applying the data to system designs. This issue replaces Issue No. 2 dated February 1960 and four Addenda thereto. New and revised depreciation and maintenance rates are included for various types of equipment.

1.2 Annual cost information set forth in this section is intended for use in engineering studies related to system designs. The recommended cost factors may be replaced by those which may be developed from analysis of appropriate individual system operating data.

1.21 The cost factors are based on telephone industry experience, modified, where appropriate, to reflect experience suitable to REA telephone systems. Use of the factors is recommended except where local conditions, unusual circumstances, or requirements of regulatory bodies indicate or dictate the use of other factors or methods.

1.3 The primary application of the annual cost data will be in the area coverage design, the details of which are discussed in REA TE & CM 205, "Preparation of an Area Coverage Design." It is essential, however, that engineering judgment govern the design process. Initial and annual cost data are intended as guidelines in economic selection studies to supplement and support engineering judgment and decisions. The objective is to choose the most suitable elements of new plant facilities. In general, the design that has the lowest annual cost should be selected. However, other considerations such as the amount of capital required, reliability and quality of service, connecting company arrangements, flexibility for meeting unforeseen conditions, or other effects on system operation may outweigh annual cost considerations.

1.4 Most of the data discussed herein applies throughout the country without change. Some local variations are included, where known, and measurable differences exist. There will be conditions existing in certain areas which will contribute to greater or lesser annual costs than those set forth. The engineer should consider these fully and in such cases use data applicable to the area. Appropriate explanations of such deviations should be included in the narrative of the area coverage design.

1.5 The following components constitute the major annual cost elements to be considered in the comparison of alternate designs:

(a) depreciation
(b) maintenance
(c) return on investment; federal, state income taxes
(d) property taxes and insurance
(e) traffic expenses
(f) miscellaneous expenses and revenues (toll settlements and balancing payments, lease of facilities, pole rentals, electrical power supply costs, etc.)

2. DEPRECIATION

2.1 Depreciation is defined as an expense due to loss in service life not restored by maintenance. It is caused by wear and tear, decay, obsolescence, and inadequacy. Additional causes may be changes in the art, fluctuations in demand, and legal requirements. Depreciation expense is established to charge the expected loss in value of a plant component to system operating costs during the expected service life of the component.

2.2 Depreciation rates distribute the original costs and other basic value of components of plant and other tangible capital assets (plus cost of removal less salvage where applicable) in a definite manner over the period of expected service life of the unit. The service life is defined as the interval between the time of installation of the unit of telephone plant and the time of its retirement.

2.3 Table I lists normal depreciation rates applicable to most units of plant. These depreciation rates are recommended for the country as a whole. It is recognized that such averages may not fully represent the variations in conditions which will be encountered. Special rates are recommended for aerial plant units installed in exceptionally corrosive atmospheres. Where physical conditions would ordinarily increase or decrease a depreciation rate noticeably, corrections are sometimes introduced through REA materials specifications. For example, 10 mil shielding or high density polyethylene outer covering of buried cables may be chosen. Buried plant terminal housings acceptable for use in corrosion areas are specified where needed.

2.31 Occasionally items of plant may be depreciated at an accelerated rate because of planned retirement much shorter than the physical life. Depreciation rates based on the expected life should be calculated for such items.

2.311 Some installations of aerial wire plant will not remain in service throughout the physical life of the wire. Borrowers who plan early retirement of aerial wire may consider higher than normal depreciation rates. Such proposed rates may require approval by the regulatory authority for the area.

2.32 The life of exposed plant items is reduced in coastal, industrial, and other areas with corrosive atmospheres. The depth of the coastal area ranges up to 20 miles from the ocean. Map I shows the general outline of coastal areas and depreciation rates that should be used for aerial wire.

2.33 From local experience within the operating region of a project, the engineer must determine any conditions which will indicate the possibility of accelerated corrosion. Such conditions might include industrial or mining installations, chemical plants, fertilizer plants, etc., where air pollution is present. Also in hot, humid areas vegetation such as Spanish Moss which collects and grows along the lines may be a cause of serious corrosion.

3. MAINTENANCE

3.1 Maintenance expense is incurred in connection with the repair, inspection, adjustment, cleaning, and rearranging of plant components and the replacement of "minor" components of plant. Minor components are those units smaller than a unit of property as defined in the applicable FCC System of Accounts. Tables I and II list estimated annual maintenance costs for use in comparative studies.

3.2 The maintenance experience of operating telephone companies indicates that factors which result in substantial variations in the initial cost of identical items of plant in different parts of the country are not necessarily reflected in maintenance expense. Therefore the method of expressing maintenance costs as a percentage of initial cost may lead to erroneous conclusions. For this reason annual maintenance charges in Tables I and II are almost entirely expressed as annual cost per unit of plant.

3.3 The Illustrative Examples presented to show annual cost comparisons in this section and in the area coverage design (TE & CM 205) use the maintenance expense estimates in Tables I and II. The engineer may adjust the estimate of annual costs for the local situation where justifiable. Such local maintenance cost experience should be of 2-3 years' duration and pertain to the particular plant components being studied.

4. RETURN ON INVESTMENT AND INCOME TAXES

4 Another component of annual cost is the return on the investment (both loan and non-loan funds) and income taxes. Because of the relationship between these two items, they have been combined into a single factor for purposes of these studies. The amounts required for these purposes will depend upon the borrower's form of organization, practices of its management, its capital structure, and any limitations imposed by the state regulatory body.

4.2 The following example illustrates a method of computing a single factor covering both the return on investment and income taxes:

(a)	Total REA loans outstanding	$ 900,000
(b)	Total equity capital (capital stock, surplus memberships, patronage capital, etc.)	100,000
(c)	Total investment or capitalization	$1,000,000
(d)	Annual interest on REA loans (2% of (a))	$ 18,000
(e)	Annual return on equity capital and/or margin for contingencies, etc. (for example, 10% of (b))	10,000
(f)	Federal and state income taxes, if any (determine borrower's ratio of such taxes to its net income or margin in latest year, for example, 40%, and apply this ratio to (e))	4,000
(g)	Required "Return and income taxes" (equals 3.2% of (c) for corporations paying income taxes and 0.4% less or 2.8% for most nonprofit corporations, with above capitalization and return)	$ 32,000

4.3 Factors developed from the borrower's experience should be modified when necessary to reflect changes in the relative amounts of loan and equity capital, tax rates, etc. The component for return and income taxes should then be tested to ascertain that it will provide the flow of cash required. For example:

(a)	Return and income taxes (net income or margin before interest and income taxes)	$ 32,000
(b)	Less income taxes, if any	4,000
(c)	Net operating income or margin	$ 28,000
(d)	Add depreciation (based on borrower's experienced or proposed composite rate)	42,000
(e)	Available for debt service	$ 70,000
(f)	Less debt service (4.24% of amount originally borrowed, not of current balance, for most REA loans)	42,400
(g)	Available for contingencies, additions and replacements, dividends, etc.	$ 27,600

4.31 To assure adequate provision for plant replacements during the debt amortization period, item (g) above should be equal to from one-half to two-thirds of item (d).

4.4 The annual charge factor for return and income taxes should be developed jointly by the borrower and the engineer. The engineer will be required to estimate the cost of construction. The borrower will indicate the nonloan funds furnished by the corporation, the desired rate of return on this investment, tax criteria, etc.

5. PROPERTY TAXES AND INSURANCE

5.1 Property taxes for operating telephone systems are frequently expressed as a percentage of the cost of construction even though, in some States, property assessments are based on physical units rather than on the book value of plant.

5.2 No suitable method of estimating property tax has been devised for new systems which would not tend to penalize higher first cost designs of some components of the system. It is therefore desirable not to include property tax in the annual cost studies of designs for new systems.

5.3 The property tax (expressed as a percentage of the cost of construction) of existing systems having approximately the same cost per station as the proposed addition should be used in the system design studies of the addition. This situation may arise for supplemental designs or when designs are prepared on a sectional basis.

5.4 The rates for fire and extended coverage insurance on buildings and their contents vary for many reasons. Attended or unattended operation, type of construction, method of heating, location and size of building are a few of the variables. Variations in rates as great as ten to one are possible so that with careful attention this annual operating expense associated with buildings and their contents can be materially reduced.

5.41 The engineer should obtain information on fire and extended coverage insurance rates locally because the geographical variations make national generalizations undesirable.

5.42 For purposes of the area coverage design the annual cost estimate for insurance on fire-resistant buildings and their contents may be assumed to be 0.2 percent. Before preparing plans and specifications for the building the engineer should determine that the total annual cost for the building is a minimum.

6. MISCELLANEOUS EXPENSES AND REVENUES

6.1 The toll settlement and operator dial service assistance (DSA) agreements are two contracts which frequently enter into economic selection studies relating principally to toll line ownership, carrier terminal location and the desirability of the borrower's providing automatic toll ticketing or station identifying service. Agreements for the joint use of electric company poles, balancing of carrier and repeater charges, and leasing of facilities from or to other telephone companies also affect annual charges for portions of plant involved in such agreements and, therefore, should be considered in annual cost studies where applicable.

6.2 Traffic expenses are the direct and indirect expenditures for providing operators to handle telephone calls and to assist subscribers. An estimate of these expenditures is required in cost studies which compare manual operation, or the cost of providing ticketing or dial assistance services, versus having the connecting company provide them.

6.3 The table below list minimum annual traffic expenses for various numbers of switchboard positions. The costs shown are for full time attendance of the switchboard. The engineer should verify that these expenses accurately reflect local wage rates before using them in cost comparisons.

Traffic Expenditure for Attended Dial and Manual Offices

Number of Positions	Traffic Expense
1	$ 15,000
2	26,000
3	36,000
4	45,000
5	53,000

Plus $9,000 for each position above five.

7. DISCUSSION OF COST STUDIES

7.1 Engineering studies for the economic selection of alternatives concerning the renewal or extension of telephone facilities should convert all costs to a common base for comparison. The annual cost or annual charge method effectively does this as it develops the total charges necessary each year to support an initial investment. Cost elements to be considered in making up annual charge comparisons should include all expenses incurred by virtue of each alternate investment. These include depreciation, maintenance, cost of money, and other expenses as previously described. Expenses for plant additions to be made at different times should be considered in the study in such a manner as to determine the proper relationship between alternate plans. The annual costs of a new facility or facilities should be supplemented where applicable to include the continuing annual costs of plant items that are being replaced.

7.2 When the annual cost comparison for two or more plans indicate less than 10 percent difference, other factors should be carefully considered in the recommendation of the optimum plan. Such factors as obsolescence, flexibility for growth, etc. may have an important bearing on the decision.

8. ILLUSTRATIVE EXAMPLES

8.1 Illustrative examples are attached to demonstrate the use of annual cost comparisons in the design of various items of plant.

8.2 In addition to the examples attached to this section, examples of annual cost studies will be found in REA TE & CM-205, "Preparation of an Area Coverage Design," and REA TE & CM-640, "Design of Buried Plant." The examples use average construction costs applicable at the time the studies were made which may be different from present costs; however, the methods demonstrated are valid.

8.3 Examples attached are:

8.31 Exhibit A - Study of Methods of Providing Additional Trunking Facilities

8.32 Exhibit B - Study of the Economy of Cable Reinforcement

8.33 Exhibit C - Study of the Economy of Cable Retention

8.34 Exhibit D - Study of Economy of Common Mode Switching Equipment

8.35 Exhibit E - Study of the Disposition of Open Wire Plant

8.36 Exhibit F - Study of Alternative Methods of Adding Service - Physical Plant, Carrier, Line Concentrator

8.37 Exhibit G - Study of Carrier/Physical Outside Plant Facilities

TABLE I DEPRECIATION AND MAINTENANCE EXPENSES

Type of Plant	Annual Depreciation Rate %	Maintenance: Plant Unit		Maintenance: Annual Expense
Buildings				
Unattended--CDO	3.3	Each Office		$ 50.00[1]
Headquarters (including warehouse and garage)	2.0	Each Installation		Initial Cost x 2%
Central Office Equipment[1]				
Dial-step-by-step	4.0	Each		$400 plus $5.00 per equipped line
Dial-step-by-step with Metropolitan EAS	5.0	Each		$400 plus $5.00 per equipped line
Dial-Common Control	3.2	Each		$400 plus $4.00 per equipped line
Local CB Manual	6.3[3]	Switchboard Position		$200.00
Toll Switchboard	4.0[4]	Switchboard Position		200.00
Automatic Toll Ticketing	5.0	Per Installation		Use 10% of 1st Cost
Automatic Number Identification	5.0	Per Installation		Use 10% of 1st Cost
Line Concentrator	5.0	Each		$500.00
Long Line Adapter	5.0	Each		12.50
Carrier (Trunk and Subscriber)[2]				Each Unit at a Location
Tube type (O.W. 1964 and earlier)	6.0	Channel End		$ 60.00
Transistor Type (O.W.)(1964 and earlier)	5.0	" "		30.00
Cable Carrier Systems	5.0	" " --where carrier repeaters are powered from CO or sub. terminal--		30.00
Station Carrier Systems (1965 and later) "EDS" "CAC" etc.	5.0	Each Channel		15.00
Repeaters (Voice Frequency, Transistor type)			CDO Mtd.	Fld. Mtd.
Negative Impedance or Resistance	5.0	Each Repeater	$5.00	$10.00
Hybrid	5.0	Each Repeater	15.00	25.00
Mobile Radio (IMTS)[2]				
Base Station	6.7	Each (excluding tower)		480.00[6]
Control Terminal	6.7	Each Unit		60.00
Mobile Units (see station equipment)				
Mobile Radio (Dispatch)[2]				
Base Station	6.7	Each Unit (excluding tower)		370.00
Mobile Unit (see station equipment)				
Point-to-Point Radio (Microwave)[2]				
RF Terminal	5.0	Each (excluding tower)		170.00[6]
Carrier Multiplex	5.0	Channel End	First Unit	60.00
		Channel End	Add. Units	15.00
Antenna Supporting Structure				
Towers requiring special painting and airway obstruction lighting	4.0	Each Structure[7]		600.00
Towers - without above; less than 170'	4.0	Each Structure[5]		80.00
Passive Repeater	4.0	Each Structure[5]		80.00
Station Equipment				
Dial	5.0	Main Station		5.00
Manual	6.7	" "		5.00
Key System Station	5.0	Extension Station		2.00[9]
Station Connections	8.0[8]			
Station Installations, drop and block wire	6.0[8]			

TABLE I (Cont'd)

Type of Plant	Annual Depreciation Rate %	Maintenance			
Station Equipment		Plant Unit	Annual Expense		
Telephone Transmitter Amplifiers	10.0	Each Amplifier	$ 1.00		
PBX Dial (Small)	6.0		Same as dial swbd.		
PBX Cordless	6.0	Each switchboard position	20.00		
PBX Cord-Non Mult.	6.0	" " "	200.00		
Booths and Fittings	6.0		Estimate		
Radiotelephone			Transistor Type	Tube Type	
Dispatch	9.0	Each Unit	$ 80.00	$ 90.00	
Dial IMTS	9.0	Each Unit	100.00		
Large Private Branch Exchanges					
Dial	6.0	(Same as Dial C.O.E.)			
Manual	6.0	Switchboard Position	200.00		
Outside Plant					
Anchors, guys, treated poles crossarms, etc.	4.5	Pole	See Table II		
Aerial Wire - Bare Steel	See Map 1	Wire Mile	See Table II		
.091 Aluminum Clad	See Map 1	Wire Mile	See Table II		
Aerial Wire--Insulated					
Steel	See Map 1	Wire Mile	See Table II		
.091 Aluminum Clad	See Map 1	Wire Mile	See Table II		
Aerial Distribution Wire--Figure 8		(State code from Table II)	A	B	C
1 pair	6.7	Sheath Mile	$ 15	$ 23	$ 30
3- 6 "	6.7	Sheath Mile	30	45	60
Aerial Cable		(State code from Table II)	A	B	C
Plastic-Insulated					
12- 25 pair	4.0	Sheath Mile	$ 45	$ 70	$ 90
50-100 "	4.0	Sheath Mile	80	120	160
Over 100 "	4.0	Sheath Mile	100	150	200
Buried Wire		(State code from Table II)	A	B	C
1 pair	5.0	Sheath Mile	$ 6	$ 8	$ 10
2 "	5.0	Sheath Mile	8	12	15
3- 6 "	5.0	Sheath Mile	10	15	20
Buried Cable					
Plastic-Insulated					
12- 25	3.4	Sheath Mile	$ 20	$ 30	$ 40
50-100 "	3.4	Sheath Mile	30	40	50
Over 100 "	3.4	Sheath Mile	40	50	60
Submarine Cable	5.0		Estimate		
Underground Cable	2.4	Sheath Mile	(Same as direct buried)		
Underground Conduit	2.0	Trench Mile	30.00		

NOTES (see TABLE I)

1. The estimated annual cost of power (or fuel) for heating, cooling or controlling the humidity should be added to these figures.

2. Power costs are included in the maintenance estimates.

3. Individual studies are required on existing equipment to properly establish an appropriate rate.

4. This depreciation rate applies to switchboards equivalent to the No. 3 type of toll switchboards.

5. Contemplates galvanized, unpainted, and unlighted steel structure with reasonable accessibility.

6. a. Increase annual expense by $130 for Standby or Frequency Diversity Terminal and non-standby repeater (2 RF units).

   b. Increase annual expense by $400 for Standby or Frequency Diversity Repeater (4 RF units).

7. Galvanized steel structure requiring painting and lighting (side lights and flashing beacon).

8. Station Connections and Installation - Companies using the simplified method for station accounting outlined in TOM Section 1865 should use a 5 percent depreciation rate. If the depreciation reserve is now over 10 percent and increasing, the annual depreciation rate should be reduced; if the reserve is below 5 percent and decreasing, the annual depreciation rate should be increased.

9. Extensions which are key system telephone sets should be counted as main stations for maintenance estimates.

TABLE II

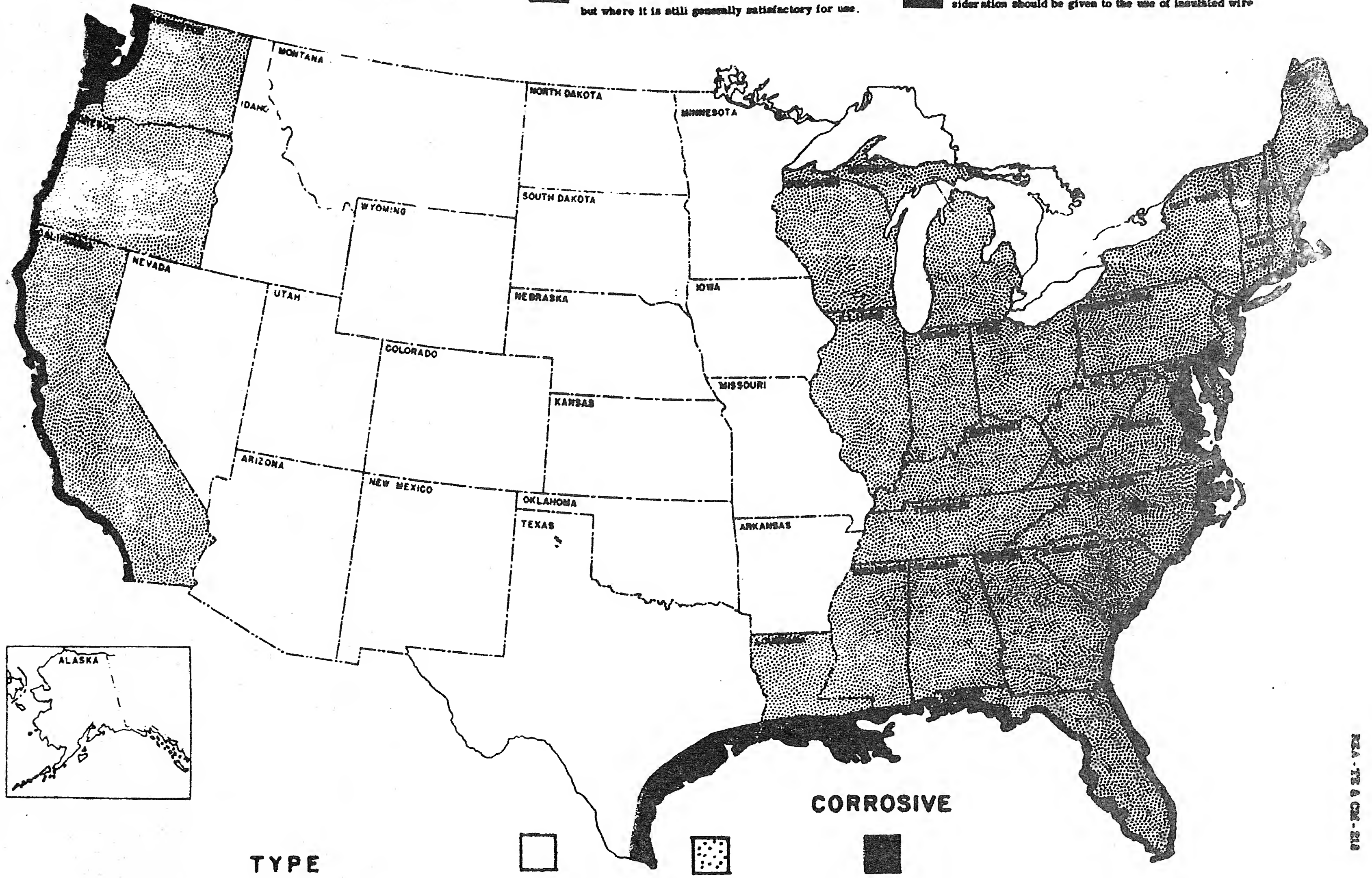
OUTSIDE PLANT ANNUAL MAINTENANCE DATA BY STATES

	*Pole Line (per pole)	Aerial Wire (per wire mile)	Aerial Cable (see Table I)	Buried Cable (see Table I)
Alabama	$.55	$3.30	B	B
Alaska	**	**	**	**
Arizona	.25	4.00	A	B
Arkansas	.55	3.30	A	A
California	.55	5.40	C	B
Connecticut	**	**	**	**
Colorado	.25	3.30	A	C
Delaware	**	**	**	**
Florida	.35	5.40	C	C
Georgia	.25	3.30	B	A
Hawaii	**	**	**	**
Idaho	.35	4.00	B	B
Illinois	.35	4.00	B	B
Indiana	.35	3.30	B	B
Iowa	.35	5.40	C	B
Kansas	.25	4.00	B	A
Kentucky	.35	4.00	B	A
Louisiana	.35	4.00	B	B
Maine	.35	4.00	A	C
Maryland	.55	4.00	C	C
Massachusetts	.55	5.40	C	C
Michigan	.35	5.40	C	B
Minnesota	.25	4.00	B	A
Mississippi	.35	4.00	A	A
Missouri	.25	4.00	B	B
Montana	.25	4.00	A	A
Nebraska	.25	5.40	B	A
Nevada	.35	4.00	C	A
N. H.	.35	3.30	A	B
New Jersey	.55	4.00	C	C
New Mexico	.25	4.00	B	B
New York	.55	5.40	B	C
N. C.	.55	3.30	B	A
N. D.	.25	5.40	B	A
Ohio	.35	4.00	B	B
Oklahoma	.25	3.30	B	B
Oregon	.35	4.00	B	C
Pa.	.55	5.40	C	B
Rhode Island	**	**	**	**
S. C.	.35	3.30	A	A
S. D.	.25	5.40	B	A
Tennessee	.35	3.30	B	B
Texas	.25	4.00	A	B
Utah	.25	3.30	A	B
Vermont	.25	3.30	A	B
Virginia	.55	4.00	B	B
Washington	.55	4.00	B	B
W. Va.	.55	5.40	C	A
Wisconsin	.35	3.30	B	B
Wyoming	.35	4.00	A	A
Puerto Rico	**	**	**	**

*Where some other utility owns the pole line, maintenance estimate should be 20 percent of above factors.
**Develop rates through special studies for each application.

DEPRECIATION RATES FOR AERIAL WIRE

- (blank) Indicates general area of the country where life expectancy of bare conductor is generally high
- (dotted) Indicates general area of the country where life expectancy of bare wire is lower than "high" but where it is still generally satisfactory for use.
- (black) Indicates general area of the country where accelerated corrosion of bare wire is anticipated and where consideration should be given to the use of insulated wire



TYPE	(blank)	(dotted)	CORROSIVE
.091 ALUMINUM CLAD	3.8	3.8	3.8
GALVANIZED STEEL	4.6	5.8	SPECIAL STUDY
INSULATED WIRE	4.6	4.6	4.6

MAP I

EXHIBIT A - STUDY OF METHODS OF PROVIDING ADDITIONAL TRUNKING FACILITIES

Aloha toll circuits are now provided via open wire carrier. In order to increase the circuits to the required number, it appears that a cable must be installed. Circuits in a cable can be obtained by voice frequency extensions from a microwave terminal in Beartown or by "back-to-back" carrier extensions from the microwave terminal using T1 carrier at an average cost of $1,200 per channel, including both terminals and intermediate repeaters. Ten repeaters in series will be required at nominal 6,000-foot intervals. A 24-channel system requires four cable pairs so a 6-pair cable is used in the cost study although a larger cable might be installed for future trunk growth or subscriber service and also for use of EAS circuits. A 50-pair cable would be chosen for 24 circuits on a physical basis. (A dual cable arrangement would cost nearly as much as the 50-pair size and increases estimated maintenance charges.)

Costs are estimated as follows:

			Physical Circuits	Carrier Circuits
INITIAL COST				
11.9 Mi. C 6-22		@ $ 1,150	$	$13,685
11.9 Mi. C50-22		@ 3,000	35,700	
24 V.F. Repeaters		@ 100	2,400	
24 Channels Carrier		@ 1,200		28,800
Total			$38,100	$42,485
ANNUAL CHARGES				
Depreciation				
Aerial Cable		@ 4%	$ 1,428	$ 547
Carrier & Repeaters		@ 5%	120	1,440
Maintenance				
Aerial Cable (0-25 Pair)		@ $ 70		840
Aerial Cable (50-100 Pair)		@ 120	1,440	
Carrier Channels	24	@ 20		480
Repeaters, V.F.	24	@ 5	120	
Return and Income Tax		@ 6%	2,286	2,549
Total			$ 5,394	$ 5,856

For this situation and its particular characteristics (distance, circuits required, need to reinforce existing plant, etc.) the initial and annual costs are fairly close. They appear to favor the physical circuits over carrier terminals. However, for longer trunk leads, varying circuit requirements, or if the growth rate is uncertain, the flexibility of carrier might be advantageous. There may be some question as to whether a second system of T carrier could be handled on the 6-pair facility. It would be preferable to evaluate a 12-pair cable/carrier arrangement versus the 50-pair facility in this situation. Carrier cost per circuit would drop substantially for additional channels as the common terminating equipment has already been included in the first system. Extra pairs in the cable would be a factor also to the extent that they can be used for subscriber or trunk service.

EXHIBIT B

STUDY OF ECONOMY OF CABLE REINFORCEMENT

A Montana borrower must install a cable to reinforce a main route from the central office for a distance of 1 mile to an intersection of three distribution routes. Each of the secondary routes will require a 50-pair 24-gauge cable. Along the main route the total estimated demand is 135 circuits for the 5-year estimate. Inspection does not reveal any attractive alternate route for connecting any of the 50-pair distribution cables at a later date; hence it appears that the main route must be reinforced when the initial cable is filled. Investment and annual charges are:

	Investment	Annual Charge Maintenance	 Other Annual*	 Total Annual
200-24	$6,500	$40	.079 x $6,500	$553.50
150-24	5,000	40	.079 x 5,000	435.00
(difference)	$1,500			$118.50

*Return and Income tax 4.5%, depreciation 3.4%

Forecasts of subscriber growth indicate that cable reinforcement will be necessary in about 9 years if the smaller cable is installed. A 50-pair cable could be provided to extend one of the 50-pair branch distribution cables.

Service requirements may change in the future, but it appears that 200 pairs will be sufficient for at least 20 years. If it is assumed that a 50-pair cable can be placed in year 9 at present costs and used to the 20th year, its cost will be:

	Investment	Annual Charge Maintenance	 Other Annual*	 Total Annual
50-24	$2,400	$30	.079 x $2,400	$219.60

A comparison of the reinforcement plan versus installing 200-pair cable initially for the 20-year period shows the following:

	Investment Difference	Annual Charge Difference
During first 8 years (each year)	$1,500 savings	$118.50 savings
Next 12 years	900 loss	101.10 loss
Full 20-year period		
12 x 101.10 - 8 x 118.50	1,200 savings	265.20 savings
Average for 20-year period		13.25 savings

On this basis, the 150-pair cable should be installed initially. The 50-pair reinforcing cable may be installed according to plan, or at a different time if growth fluctuates. Also, carrier circuits are available, and the third alternate of reinforcing by carrier should be considered for additional flexibility. It may be desirable to plan for reinforcement on an alternate route which will afford relief when needed and at the same time assist in providing the most economical means of serving neighboring areas also having growth.

A reinforcement study such as this example should not be applied to situations involving only short distances as the extra splicing and the rearrangements at the time of reinforcement will frequently offset any expected saving.

(Some differences would result in the above comparative costs if annual present worth factors were utilized. There would be an increase in the benefit of deferring the cost of the 50-pair cable which would increase the savings in annual charges.)

EXHIBIT C

STUDY OF THE ECONOMY OF CABLE RETENTION

Under the same conditions described in the previous cable reinforcement problem assume that there is an existing 51-pair, 22-gauge lead sheathed cable along the route in question. Study the desirability of reinforcing it with 150-pair plastic-insulated cable initially versus replacing it with 200-pair, 24-gauge cable. Assume, if retired, that the 51-pair cable would have a 10 percent salvage value.

	Plan I	Plan II		
		Replace 51-22L With 200-22P		
Investment	Retain & Reinforce	Premature Retirement	Removal	Replace
51-22L	$ 4,160	$ 3,845 1/	$ 800	$
150-24P Cable	5,000			
200-24P Cable	-			6,500
	$ 9,160	$ 3,845	$ 800	$ 6,500
Annual Cost				
Maintenance	$ 205	$	$	$ 100
Removal			800	
Depreciation @ 3.1%	129	119		
Depreciation @ 4%	200			352
Return & Income Tax 4.1%	376	231 2/		361
	$ 910	$ 350	$ 800	$ 813

1/ The cable and terminals are not reusable. Salvage value is 10 percent of the original material cost (10% of $3,150 = $315)

2/ Based on earnings on equity money (6%); excludes income tax.

SUMMARY

Annual Cost	Plan I (Retain)	Plan II (Replace)
Retain and Reinforce (20 x 910.)	$18,200	$
Replace 20 x $813		16,260
20 x $350		7,000
1 x $800		800
Total Annual Cost (20 Years)	$18,200	$24,060
Average Annual Cost (20 Years)	$ 910	$ 1,203
New Money Required		
New Cable	$ 5,000	$ 6,500
Remove Cable		800
Salvage 51-22L		1,890
	$ 5,000	$ 5,410

The difference in annual charges favors Plan I: This plan may be chosen if the remaining service life and condition of the 51-pair paper-insulated cable is satisfactory.

EXHIBIT D

STUDY OF ECONOMY OF "COMMON MODE" SWITCHING EQUIPMENT

A borrower in Alabama desires to evaluate costs to upgrade to one-party service using fine gauge cable facilities. Construction costs are estimated by the engineer as follows:

Initial Cost

Outside Plant - rural		$266,905
town		173,336
COE - Long line adapters 476 @ $100		47,600
- Voice frequency repeaters 202 @ $100		20,200
		$508,041

Annual Charges

Outside Plant 9% (Maintenance omitted as common to both plans.)		$ 39,622
Long line adapters		
Depreciation 5% x $100	= $ 5.00 ea.	
Return, income tax, ins. 5% x $100	= 5.00 ea.	
Maintenance	12.50 ea.	
476 LLA @	$22.50	10,710
Voice frequency repeaters		
Depreciation 5% x $100	= $ 5.00 ea.	
Return, income tax, ins. 5% x $100	= 5.00 ea.	
Maintenance (c.o. mounted)	5.00 ea.	
202 VFR @	$15.00	3,030
	Total	$ 53,362

In view of the large quantity of long line equipment needed because of the relatively low density of the subscribers, a comparison of the costs of using common mode (CMO) equipment are prepared. These results are:

Initial Cost

Outside Plant		$440,241
COE - Long line adapters 41 @ $100		4,100
- Voice frequency repeaters 51 @ $100		5,100
Additional switching equipment		2,300
	Total	$451,741

Annual Charges

Outside Plant 9% - (omits maintenance)		$ 39,622
Long line adapters		
Depreciation 5% x $100	= $ 5.00 ea.	
Return, income tax, ins. 5% x $100	= 5.00 ea.	
Maintenance	12.50 ea.	
41 LLA @	$22.50 ea.	922.50

EXHIBIT D Con.

Voice frequency repeaters		
Depreciation 5% x $100	= $ 5.00 ea.	
Return, income tax, ins. 5% x $100	= 5.00 ea.	
Maintenance (c.o. mtd.)	5.00 ea.	
51 VFR @	$15.00	765
Switching equipment charge @ 20%		460
	Total	$ 41,769.50

The above comparison indicates a savings of more than 20 percent in annual charges through the usage of central office "common mode" equipment arrangements in conjunction with fine gauge cable plant. There may be additional advantages that should be studied such as using field-mounted repeaters, application of existing serviceable cables which may be heavier gauge, etc.

EXHIBIT E

STUDY OF THE DISPOSITION OF OPEN WIRE PLANT

A Minnesota borrower has approximately 30 miles of 2-wire line. This plant consists of copper-steel wire with approximately 18 poles per mile. It is estimated that the wire and most of the poles will have 8 years of remaining life.

Three plans will be considered. The cost of removal of the existing plant will be assumed to be the same in each plan. None of the displaced plant is reusable.

Plan I - Completely replace the existing line using buried wire.

Plan II - Rehabilitate the existing facilities, trim foliage, resag conductors, etc., to render the plant in A-1 condition for minimum maintenance for the estimated 8 years remaining life.

Plan III - Do nothing at present. This means spending no money this year except assuming a higher annual maintenance charge which is three times the normal rates per pole line mile and per wire mile.

A time period of study of 25 years will be used. Premature retirement is credited in Plan II and Plan III rather than charged to Plan I. It is assumed that the new plant slowly rise in cost from $800, to $900, to $1,000 per mile.

	Premature Retirement		Plan I Convert to buried this year	Plan II Rehabilitate for 8 more years life			Plan III Do nothing for 5 yrs. Must pay higher maintenance	
	8 years	5 years	(1968)		(1968)			(1973)
Original Cost			$					$
Pole line	$300.00	$400.00		$540.00		$1,000.00	$400.00	
Aerial Wire	140.00	140.00		140.00			140.00	900.00
Buried Wire			800.00					
Total	$440.00	$540.00	$800.00	$680.00		$1,000.00	$540.00	$900.00
Annual Cost								
Maintenance	$	$	$	$	$	$	$	$
Pole line				4.50	228		13.50	
Aerial Wire				8.00			24.00	
Buried Wire			6.00			6.00		6.00
Trimming				34.00			34.00	
Depreciation								
Pole line 4.5%	13.50	18.00		24.30			18.00	
Aerial Wire 4.6%	6.44	6.44		6.45			6.45	
Buried Wire 5%			40.00			50.00		45.00
Return & Income Tax 6.6%	26.40 (3)	32.40 (3)	52.80	44.88		66.00	35.60	59.40
Total Annual Cost	$ 46.34	$ 56.84	$ 98.80	$122.13	$228	$ 122.00	$131.55	$110.40

(3) Based on earnings on equity money 6 percent - excludes income tax

EXHIBIT E Con.

	Plan I Convert to buried this year	Plan II Rehabilitate for 8 more years life	Plan II Do nothing for 5 years; pay higher maintenance
Complete Conversion Rehabilitation	25 x $98.80 = $2,470.00	17 x $122.00 = $2,074.00 1 x 228.00 = 228.00 8 x 122.13 = 977.04	20 x $110.40 = $2,208.00 5 x 131.55 657.75
Premature Retirement Credit		8 x 46.34 = - 370.72	5 x 56.84 = - 284.20 3 x 46.34 = - 139.02
Total	$2,470.00	$2,908.32	$2,442.53
Average annual charge for 25 years	$ 98.80	$ 116.33	$ 97.70

Total New Money Required for Thirty Miles of Line

	Plan I	Plan II	Plan III
1968	30 x $800 = $24,000	30 x $228 = $ 6,840	
1973			30 x $900 = $27,000
1976		30 x $1,000 = $30,000	
Total	$24,000	$36,840	$27,000
Present Worth Basis 5%	($24,000)	($27,144)	($21,155)

On the basis of the annual cost study, Plan III is recommended. This plan is also optimum from the present worth standpoint which recognizes the value of the postponed capital investment.

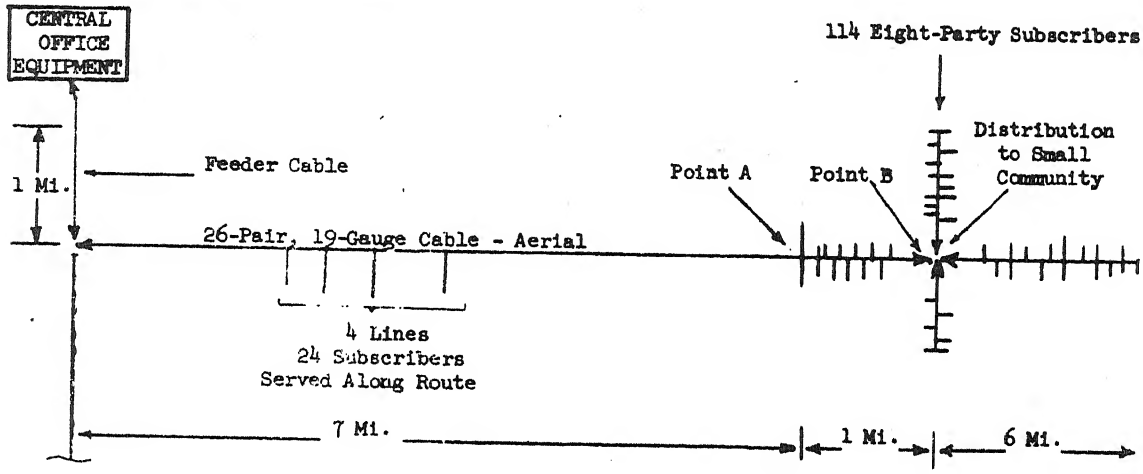
EXHIBIT F

STUDY OF ALTERNATIVE METHODS OF ADDING SERVICE
BY PHYSICAL PLANT; CARRIER; AND LINE CONCENTRATOR

(This example is intended to provide information required in the economic selection studies of alternate methods of providing additional service when existing cable is filled. In particular it compares adding a second cable, using carrier equipment, and installing a line concentrator as alternative methods of providing service.)

A borrower serves a small community through a 26-pair, 19-gauge plastic aerial cable from a central office in a nearby town. The condition of the plant is excellent.

A sketch of the arrangement is shown below:



The following services are in use:

138 Eight-party subscribers	on 22 lines (including 4 lines along route)	
2 PBX lines in a group	on 2 lines	
2 One-party businesses	on 2 lines	
Total	26 lines	

The following additional services are needed in or beyond the community:

- Upgrade 7 existing subscribers to two-party.
- Upgrade 91 existing subscribers to four-party.
- Add 21 four-party subscribers.
- Add 2 more PBX lines to the group.

When the new services are installed the arrangement will be as follows:

112 Four-party subscribers	on 35 lines
7 Two-party subscribers	on 4 lines
4 PBX lines in a group	on 4 lines
2 One-party businesses	on 2 lines
	45 lines

Three plans will be studied. The distribution beyc
the amount of central office equipment will b

PLAN I - Reinforce existing cable with

PLAN II - Install subscriber carrier at

PLAN III - Install a line concentrator

EXHIBIT F Con.
PLAN III Con.

Traffic Computation

Service	No.	UC
Four-party	102 x	.6 = 61.0
Two-party	7 x	.8 = 5.6
PBX	2 x	4.0 = 8

74.6 x 2 = 149.2 UC

Requires minimum of 10 concentrator trunks - 12 are shown above - 4 spares still remain in the cable.

Investment

Line Concentrator	$ 5,000
Add 5% for installation	250
Cable - Add 1 mile, 25 pair, 22 gauge @ $2,000	2,000
	$ 7,250

Annual Charge

Maintenance - Concentrator	500
One sheath mile cable @ $40.00	40
Depreciation 5.0% (for study purposes)	
Insurance .2%	
Return and Tax 5.0%	
10.2% x $5,250	536
Depreciation, return and tax on cable 8.4% x $2,000	168
Total	$ 1,244

CONCLUSION

The comparison of the three plans is as follows:

	Initial Cost	Annual Charges
PLAN I - Cable	$17,953	$ 1,920
PLAN II - Station Carrier	15,635	1,985
PLAN III - Concentrator	7,250	1,244

It should be noticed that the three service methods are not equivalent with respect to capacity and growth:

PLAN I - Cable	51 pairs (45 subscribers; 6 spares)
PLAN II - Station Carrier	26 channels (on 7 pairs) plus 19 physical subscriber circuits = 45 "lines" available. There are no spares, but additional channels can be added as needed.
PLAN III - Concentrator	3 physicals used on route; 4 bypass concentrator (15 pairs serve it, with 4 spares). There are 49 concentrator lines (38 working, 11 spares) = 66 "lines" available plus the 4 spare pairs which can be used for either concentrator trunks or subscribers.

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EXHIBIT G

STUDY OF CARRIER/PHYSICAL OUTSIDE PLANT FACILITIES

New types of equipment and flexible design techniques make it possible to maintain economy in plant costs and avoid excessive fixed plant investment. The improvement of service and the conservation of copper are also important factors. Solid state electronics has produced new repeaters and carrier equipment to aid in these objectives. Such devices should be carefully considered wherever new circuitry is necessary.

In the following example, the application and cost comparison of station carrier is studied to reinforce outside plant. In this exchange plant problem, a need has arisen for more circuits than are available.

A line diagram of the existing facilities and additional requirements are as follows:

C.O.	BJ 50-22 3.4 Mi.	BJ 25-22 4.8 Mi.	RDW 12-19 .9 Mi.	6P 4W 1.2 Mi.	2P 2W .9 Mi.
	←		11.2 miles		→
Additional Circuit Requirements*	+18	+12	+6	+3	+2
Total Service	68	37	18	5	3

*Recommended standard sizes per Table I, TE & CM 210.

Cost Analysis based on additional physical plant:

		Unit Cost	Total	Unit R	R	Cumulative R**
3.4 Mi.	BJ 18-24	$ 1,450	$ 4,930	274 ohms	930 ohms	930 ohms
4.8 Mi.	BJ 12-24	1,265	6,072	274 "	1310 "	2240 "
.9 Mi.	BW 6-24	1,000	900	274 "	246 "	2486 "
1.2 Mi.	BW 3-22	1,020	1,224	171 "	205 "	2691 "
.9 Mi.	BW 2-19	900	810	85 "	77 "	2768 "
			$13,936			

**Load coil resistance omitted for simplicity.

(12 LLA @ $125
(12 VFR @ $ 70 — 2,340

Total cost estimate — $16,276

Additional equipment for circuits over 1700 ohms--probably fewer would be required depending on where 1700 ohms boundary actually is located.

Analysis based on using carrier equipment. If single channel carrier equipment is considered for adding circuits to 18 kilofeet over nonloaded pairs and four-channel carrier is superimposed for additional circuits over 18 kilofeet, an arrangement will result such as the following:

Rptr. Pts.

C.O.	BJ 50-22 3.4 Mi.	BJ 25-22 4.8 Mi.	RDW 12-19 .9 Mi.	4P 4W 1.2 Mi.	2P 2W .9 Mi.
MP CXR Channels	16	16	8	4	3
1 Party CXR Channels	6				
Physicals - Sub. & Spare	46	21	10	1	
Carrier Physicals	(4)	(4)	(2)	(1)	(1)
Total Service	68	37	18	5	3

The single channel carrier does not disable the physical. The four-channel type requires a physical for each system. These pairs must be cleared of load coils. Four carrier repeaters are required at 3.65 miles and two at 7 miles from the central office.

The estimated costs for the carrier apparatus are:

16 Multiparty Carrier Channels	@ $440	$ 7,040
16 Station Accessories	@ 25	400
Central Office Power & Signal Accessories		500
6 Carrier Repeaters	@ 225	1,350
6 Single Channel Carrier Channels	@ 225	1,350
Misc. load coil removal, etc.		400
		$11,040
Installation @ 5% = $552	use	560
Total cost estimate		$11,600

On an annual charge basis the alternate plans compare as follows:

PLAN I Add physicals

Return & tax $16,276 @ 5%			$ 814
Depreciation:			
Buried cable	$11,002 @ 3.4%		374
Buried wire	2,934 @ 5%		147
LLA; VFR	2,340 @ 5%		117
Maintenance:			
Cable and Wire	.9 Mi. @ $ 8 Sheath Mi.		7
	2.1 Mi. @ 10 Sheath Mi.		21
	3.4 Mi. @ 20 Sheath Mi.		68
	4.8 Mi. @ 20 Sheath Mi.		95
LLA	12 @ 12.50 each		150
VFR	12 @ 5.00 each		60
		Total	$ 1,854

PLAN II Add carrier

Return & tax	$11,600 @ 5% =		$ 580
Depreciation	11,600 @ 5% =		580
Maintenance	22 @ $15.00 channel =		330
		Total	$ 1,490

A summary of the above cost data indicates:

	Plan I Physical	Plan II Electronic
Initial Cost	$16,276	$11,600
Annual Cost	$ 1,854	$ 1,490

The cost for adding electronic equipment is substantially less in the above example, which covers only one selected lead, than the cost of adding cable type plant to establish the equivalent number of circuits. Such savings can often be expected if the existing circuits are satisfactory for carrier transmission and the addition of reinforcing physicals is not required. Existing plant would need to be augmented if it included superseded types of distribution wire or other facilities not compatible for carrier.

It is of interest to ascertain the relative costs of adding reinforcing physical plant or carrier on a larger scale. Accordingly the assumed subscriber increases establishing the "Existing," and the "Additional Circuit" requirements are doubled and tripled to evaluate the differences in the results. For twice the requirements above: